PB-245 744

REPORT ON POLLUTION OF INTERSTATE WATERS OF THE CONNECTICUT RIVER. MASSACHUSETTS-CONNECTICUT

Robert A. Taft Sanitary Engineering Center
Cincinnati, Ohio

November 1963

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REPORT ON
POLLUTION OF INTERSTATE WATERS
of the

CONNECTICUT RIVER
MASSACHUSETTS-CONNECTICUT

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U. S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
Robert A. Taft Sanitary Engineering Center
Cincinnati, Ohio

NOVEMBER 1963

BIBLIOGRAPHIC DATA SHEET	1. Report No.	2.	3. Recipient's Accession No.
4. Title and Subtitle Report on Pollution of Interstate Waters of the Connecticut River Massachusetts - Connecticut			5. Report Date Nov. 1963 6.
7. Author(s)			8. Performing Organization Rept. No.
9. Performing Organization Name and Address U.S. Dept of Health, Education, & Welfare Robert A. Taft Sanitary Engineering Center<br~~Cincinnati~~ Cincinnati, Ohio.			10. Project/Task/Work Unit No. 11. Contract/Grant No.
12. Sponsoring Organization Name and Address U.S. Dept. of Health, Education, & Welfare Cincinnati, Ohio.			13. Type of Report & Period Covered 14.

15. Supplementary Notes

16. Abstracts

The report examines the pollution found in the Connecticut River. The uses of the water are described along with the sources of waste. Conclusions are drawn from the effects of pollution on water quality and uses.

17. Key Words and Document Analysis. 17a. Descriptors

* Water quality
* Stream pollution
* Industrial wastes
Sewage

17b. Identifiers/Open-Ended Terms

* Connecticut River
Solid wastes

17c. COSATI Field/Group

PRICES SUBJECT TO CHANGE

18. Availability Statement	19. Security Class (This Report)	21. No. of Pages
Release unlimited	UNCLASSIFIED	65
	20. Security Class (This Page) UNCLASSIFIED	22. Price 4.25

FORM NTIS-35 (REV. 10-73) ENDORSED BY ANSI AND UNESCO. THIS FORM MAY BE REPRODUCED USCOMM-DC 8265-P74

SEE ALSO
PB 229 717

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REPORT ON
POLLUTION OF INTERSTATE WATERS OF
THE CONNECTICUT RIVER
MASSACHUSETTS-CONNECTICUT

INTRODUCTION

On the basis of reports that gave him reason to believe that pollution of the Connecticut River in Massachusetts was endangering the health or welfare of persons in Connecticut, the Secretary of Health, Education and Welfare called a Conference of the Public Health Service and the state and interstate water pollution control agencies concerned, to be held in Hartford, Connecticut, on December 2, 1963.

This report on pollution of interstate waters of the Connecticut River is based on: previous reports; data and other material obtained from the Massachusetts Department of Public Health, the Connecticut Water Resources Commission, and the New England Interstate Water Pollution Control Commission; information furnished by other interested state and local agencies and individuals; official records of the Public Health Service; and data obtained by the Public Health Service through a field study conducted during the period September 30 through October 11, 1963.

The Massachusetts Department of Public Health provided a boat, participated in the preliminary reconnaissance of the river and the collection of samples, and sampled and analyzed sewage at the treatment plants. The Connecticut Board of Fisheries and Game furnished a boat and assisted in sampling. The Springfield, Massachusetts, Bondi Island Sewage Treatment Plant provided space and utilities for the Public Health Service mobile laboratory.

The wholehearted and invaluable cooperation of the numerous agencies and individuals is gratefully acknowledged.

THE AREA

The Connecticut River is the major interstate stream of the New England States. Rising in the northern tip of New Hampshire near the Canadian border, the river flows south for nearly 400 miles to join the Atlantic Ocean in Long Island Sound. It forms the boundary between New Hampshire and Vermont and travels across both Massachusetts and Connecticut on its way to the sea.

From headwaters to mouth the river drops nearly one-third of a mile. Formerly it tumbled over many rocky rapids, but most of these either have been buried beneath impoundments created to produce power, or have been bypassed with canals constructed to permit navigation and to conduct water to manufacturing plants for production of power and for use in industrial processes. Other means of transportation have largely replaced navigation but the canals still serve as sources of power and water supply for industries.

The Connecticut, viewed at a distance, is a beautiful river. Its broad expanses of water flowing in sweeping bends between tree-lined banks, through both impounded and uncontrolled reaches, enchant

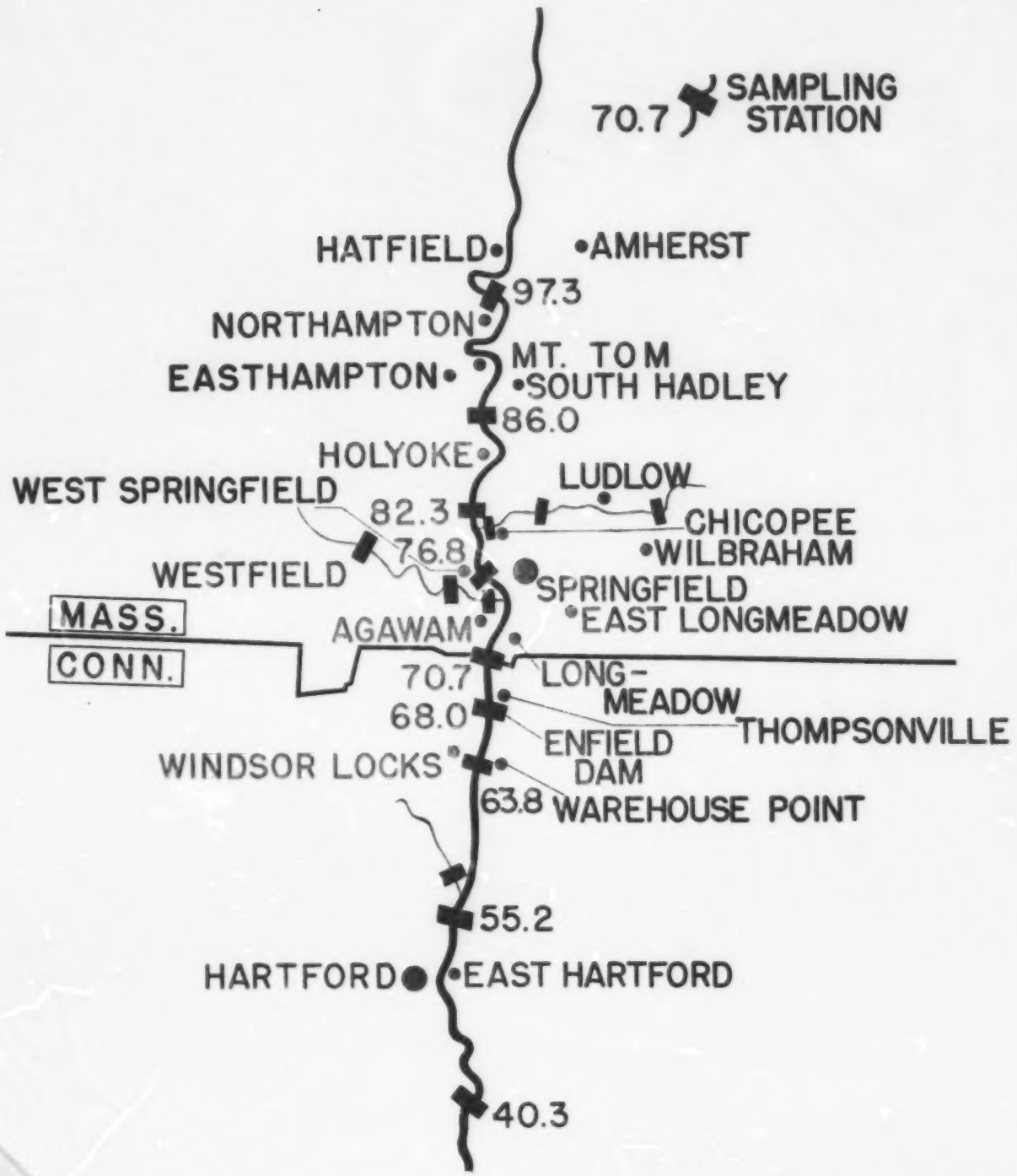
the eye. The quiet impounded waters invite pleasure boating, swimming and skiing. The free-flowing reaches challenge the canoeist and the fisherman. The potential for recreation is great, but has not yet been fully realized. In some areas, when viewed at close range, the ugly evidences of pollution disenchant the aesthetic sensibilities, and dampen enthusiasm for contact with the water. As a result the Connecticut River has achieved a reputation locally as a dirty, polluted stream, and this inevitably has interferred with its development and use for recreation.

The 62-mile reach of the river (Figure 1) covered by this report extends from Hatfield, Massachusetts, to the Rocky Hill-South Glastonbury Ferry, 12 miles below Hartford. Of this reach, 32 miles are in Massachusetts and 30 in Connecticut. Thirty-eight miles are impounded by the Holyoke and Enfield dams, eight miles are free flowing, and 16 miles are subject to tidal fluctuation.

Portions of two major tributaries which receive sewage and industrial wastes in Massachusetts, and enter the Connecticut near Springfield, also are covered in this report. These are the Chicopee River from North Wilbraham to its mouth, and the Westfield River from Westfield to its mouth. Like the Connecticut, both of the tributaries have been developed to provide power and water supply for industry. The 12.5 mile reach of the Chicopee is a series of six impoundments totaling

CONNECTICUT RIVER

FIGURE 1



about 10 miles in length, separated by brief stretches of free flowing water. The 11.5 mile reach of the Westfield River includes two small impoundments and about 11 miles of open stream.

Along the three stream reaches in Massachusetts are 15 towns, one village* and a Federal Air Force Base discharging sewage from an estimated total sewered population of 428,400. Seven of these towns and the village, with an estimated total sewered population of 146,200, discharge sewage without treatment. Springfield, with primary treatment, is the major city of the area.

Within this same area 10 paper mills, a textile mill, three metal working plants, three synthetic chemical plants, a rendering plant and a brewery discharge industrial wastes to the streams. The oxygen demand population equivalent (PE) of the industrial wastes from all plants is estimated to be 96,900.

Along the reach of the main river in Connecticut are five jurisdictions, with an estimated total sewered population of 305,800. One of these,** with a sewered population of 1,240, discharges sewage without treatment. The major city of the area is Hartford, which provides primary treatment for a major portion of the metropolitan area.

Only one industry discharges a significant quantity of waste to the Connecticut River above the Hartford area. This is a paper mill with an estimated organic population equivalent of about 500.

* Mt. Tom - although a portion of Easthampton, this village is listed separately in official inventories.
** Warehouse Point - about two-thirds of the sewered population are in a state institution.

As members of the New England Interstate Water Pollution Control Commission, Massachusetts and Connecticut in 1955 classified the Connecticut River in the two states. At that time the river from Holyoke Dam in Massachusetts to Middletown, Connecticut, was judged to be in the condition described by Class D of the Interstate Commission, with the exception of a few miles above Hartford, which was judged to be Class C. The uses for which Class D water quality is suitable are "transportation of sewage and industrial wastes without nuisance and for power, navigation and certain industrial uses." The Commission approved the future highest use classification of the river from Holyoke to Hartford as C. Class C water quality is described as being "suitable for recreational boating, irrigation of crops not used for consumption without cooking; habitat for wildlife and common food and game fishes indigenous to the region; industrial cooling and most industrial process uses." Among other requirements, Class C waters shall have not less than 5 parts per million of dissolved oxygen. Oil, grease, color and turbidity shall not be objectionable, and there shall be no odor, scum, floating solids, debris and sludge deposits. No limiting values have been imposed on bacterial pollution.

At the time the classification was adopted five of the towns involved along the Massachusetts reach of the river had sewage treatment. In the eight years since that time three additional towns with a sewered population of 55,500 have provided treatment, and two of the original

plants have been rebuilt or replaced. Eight jurisdictions with a sewered population of 146,200 still are without treatment.

It has been reported that Massachusetts towns, hard hit by the loss of numerous industries, have delayed sewage treatment in hopes of more financial assistance through Federal or State grants.

Generally industries have been unwilling to provide treatment before the towns. There has been hesitancy in placing pressure on the industries because of concern that this might hasten their removal from the state.

WATER USES

Along this 62 mile reach the Connecticut River is used principally for industrial water supply, recreation, power production and waste disposal. There is some navigation and commercial fishing.

INDUSTRIAL WATER SUPPLY

The Connecticut provides such an abundance of water for industrial supply in this reach that the industries are said not to bother with records of water use. Previous attempts to assemble such data have been unsuccessful.

At Holyoke an intricate system of three canals at different levels traverses the city to carry water directly to the numerous industries located along the canals. Five paper mills, which lead the Nation in production of writing paper and are large users of water, draw their supplies from these canals. Several industries in West Springfield take water from the Connecticut River. A canal parallels the river from Enfield Dam for five miles downstream to Windsor Locks where it furnishes power and water supply for several industrial plants.

The Chicopee River furnishes water to industries in Springfield, Chicopee and Chicopee Falls, and the Westfield River is the source of supply for industries in Westfield and West Springfield.

Four thermal power plants use large quantities of Connecticut River water for cooling. Two of these alone use about 317 million gallons per day.

The Pratt and Whitney Division, United Aircraft Corporation, at East Hartford, uses 720 million gallons of water per day for cooling.

In Connecticut above Hartford one large paper mill uses several million gallons of river water per day from Windsor Canal. Several small industries draw limited quantities of water from the canal also.

RECREATION

The very real potential of this reach of the Connecticut River for recreational uses has not fully been realized. Of all existing uses, fishing for shad during the spring run of this anadromous fish is the most popular and attracts the most attention. In step with the trend throughout the Nation pleasure boating is increasing in popularity as a water sport, though it has not developed as rapidly as it has elsewhere.

Fishing

From late April through early June of each year large numbers of shad travel up the Connecticut River to spawn. During these runs

sport fishermen take to the river to catch their share of these fighting fish. By all accounts, this period of the year witnesses the most intensive recreational use of this reach of the Connecticut. It has been said that one almost could cross the river by stepping from fishing boat to fishing boat in some areas when the shad run is on. Many fishermen line the banks near access points, and others crowd suitable bridges.

About one-third of the shad fishing is concentrated at eight state-controlled areas from the mouth of the Farmington River to South Hadley Bridge in Holyoke. Six of these are in Connecticut between Enfield Dam and the Farmington River, and two are in Massachusetts. Information compiled from the controlled areas provides the basis for the data below.

For the 10-year period from 1953 through 1962, during the few weeks of the shad run each year, sport fishermen spent an average of about 19,000 man days per year in pursuit of the shad. The success of their efforts is reflected by the average of 27,200 shad taken each year. In 1963 the man days reached a high of about 26,000, with a record catch of 52,000.

River flow usually is high at the time of the shad run each year, and the fish are able to pass the low Enfield Dam through a special runway near one end of the dam. At the higher Holyoke Dam they need assistance to continue upstream, and this is provided by

the Holyoke Water Power Company, which operates an elevator type fishway or lift to serve their finny passengers. The aquatic elevator was first operated in 1955, when 4,900 shad were transferred from the river below to the impoundment above the dam. The patronage of the elevator has steadily increased since then, with 30,000 shad riding it over the dam in 1963 to continue to spawning grounds in Holyoke impoundment and its tributaries. This year shad were taken as far upstream as Deerfield Dam, which bars their further passage.

The Connecticut River supports a variety of game and coarse fish. These include yellow perch, bullhead, white and channel catfish, large-mouthed bass, chain pickerel, white perch, northern pike, carp and suckers. For some unexplained reason there has been only limited angling for any type of fish other than shad. A former Chief of the Division of Fisheries, Connecticut Board of Fisheries and Game, puzzled by the limited use of this excellent fishery, has hypothesized that: "It may be possible that many sportsmen associate the river with gross pollution and uncleanliness and feel it unlikely to consider sport fishing in such an environment - further, that fish from the river are unfit as food." He added, however, that shad, which are intolerant of poor water quality, are again prospering in the river. Fortunately, adult shad ascend the river when flows are high and are not subjected to the most critical effects of pollution. The young shad feed on suspended microscopic plants and animals and are not dependent on bottom

organisms for food. The semi-buoyant shad eggs move with the river current and do rest on the sewage sludge where it covers the river bottom.

Boating

The greatest use of the river for pleasure boating occurs in the Holyoke impoundment in the Northampton area and in the tidal reach of the river below Hartford. A limited amount of boating is reported in the tidal reach above Hartford, and in the Enfield impoundment. There is no channel suitable for motor boating between Enfield Dam and tidewater, and there are channel restrictions in Enfield impoundment.

In the Holyoke impoundment between the dam and Northampton there are two commercial boat ramps and docking facilities, a mooring area, and a canoe club. A water skiing club patronizes one of the commercial marinas. There are three commercial ramps and moorages for pleasure boats, and a yacht club in the Enfield impoundment between the state line and Holyoke.

Four public access areas in Connecticut accommodate pleasure boats between the state line and Hartford. These are designated as Thompsonville, Enfield, Windsor and Wilson. The Connecticut Board of Fisheries and Game has plans for providing more public access areas and better facilities to encourage increased use of the excellent fishery available in this reach of the river.

Two commercial agencies rent boats to shad fishermen just below Windsor Locks.

Swimming

Only one bathing beach was noted in the area under consideration. This was at the boat ramp and moorage at Northampton. Where there is suitable water, however, some of those who live near the stream, some pleasure boaters and fishermen, and some who visit the river to enjoy being near water will swim on an unorganized basis. The Connecticut River undoubtedly is no exception to this generalization.

Skiing

The tremendous national increase in popularity of pleasure boating inevitably has been followed by an increase in water skiing. While this sport apparently has not become popular so rapidly along the Connecticut as it has on other waters, there has been a start, as evidenced by the ski club on Holyoke impoundment. Popularity of this sport undoubtedly will increase. The quiet waters of the Holyoke impoundment and of the tidal section in the vicinity of Hartford are the most suitable river reaches for this sport, which invariably involves body contact with the water.

COMMERCIAL FISHING

Commercial shad fishing is permitted in the Connecticut River in Connecticut but not in Massachusetts. The shad run is followed by commercial fishermen as it proceeds upstream from the mouth of the river to Enfield Dam. During the 10-year period from 1953 through 1962 commercial fishermen have netted an average of 98,200 shad yearly.

NAVIGATION

Navigation on the Connecticut is limited to the tidal reach of the river below Hartford. Several oil barges make the trip from Long Island Sound to Hartford each day, and some of the coal used for thermal power production in Hartford is transported by water.

HYDRO POWER

It is said that the entire flow of the Connecticut River during low flow periods is used two to three times over for power production.

The principal hydro power use is at Holyoke and Windsor Locks. At Holyoke the three-canal system provides head for power to serve many of the industries. The Holyoke Water Power Company draws water from the impoundment to produce electric current. The Windsor Canal

provides power for industries situated at Windsor Locks. The Chicopee and Westfield rivers also produce electric power.

During periods of low flow the entire flow of the Connecticut River, with the exception of about 200 cfs of leakage, is retained by the Holyoke Dam on Saturdays and Sundays. This two-day reduction in flow each week seriously affects waste disposal in the Enfield impoundment.

SOURCES OF WASTES

Raw and partially treated sewage and industrial wastes cause excessive pollution of certain reaches of the Connecticut, the Chicopee and the Westfield rivers in Massachusetts, and the Connecticut River in Connecticut.

SEWAGE

Sewage contains numerous constituents which may have adverse effects on water quality and uses. Of these, bacteria, suspended solids and oxygen demanding materials generally are most important. The content of sewage from either untreated or treated sources may be described in terms of bacterial, suspended solids or oxygen demand population equivalents. The population equivalents are the sewered populations that would produce raw sewage having equivalent quantities of bacteria, suspended solids, or oxygen demand.

Eight of the 22 jurisdictions responsible for the discharge of sewage involved in this study provide no treatment. Twelve of the

22 provide primary treatment, or sedimentation, which removes only limited portions of the pollutional constitutents. One discharges both raw and primary treated sewage. Three of the primary plants are equipped to chlorinate the sewage during the recreational season. Chlorination can achieve major reductions in the bacterial content of sewage, but accomplishes little reduction in other constituents. One of the 22 jurisdictions provides secondary treatment, which includes a biological process, and chlorination. This combination of processes may accomplish the maximum reductions in all pollutional constituents that are feasible by present conventional sewage treatment methods. All of the treatment methods permit some residual materials to enter the receiving stream.

Bacteria

The total sewered population of the 22 jurisdictions is estimated to be 734,000. The treatment presently provided is estimated to reduce the over-all bacterial content of the sewage about 44 per cent, leaving bacteria equivalent to those in the raw sewage from 413,000 persons to enter the streams.

The estimated bacterial loads from the various sources of sewage, with estimated allowances for any treatment provided, are presented in Table 1. The loads are expressed in terms of bacterial population equivalents (BPE). A bacterial population equivalent may be defined as the

CONNECTICUT RIVER
MASSACHUSETTS-CONNECTICUT

TABLE 1

Estimated Characteristics of Sewage Discharged to Connecticut River and Tributaries between Northampton, Massachusetts, and South Glastonbury-Rocky Hill Ferry, Connecticut.

JURISDICTION	STATE	RECEIVING STREAM	Type of System*	Type of Treatment	Sewered Population	Population Equivalents Discharged					
						Bacterial		Suspended Solids		Oxygen Demand	
						Number	% Total	Number	% Total	Number	% Total
Hatfield	Mass.	Mill River	C	None	1,300	1,300	0.31	1,300	0.29	1,300	0.23
Amherst	Mass.	Connecticut River	S	Primary and Cl	16,000	1,200	0.29	4,290	0.95	6,950	1.24
Northampton	Mass.	Connecticut River	S	Primary and Cl	30,000	2,250	0.54	10,000	2.25	18,700	3.35
Mt. Tom	Mass.	Connecticut River	S	None	200	200	0.05	200	0.04	200	0.04
East Hampton	Mass.	Connecticut River	S	Primary and Cl	11,100	830	0.20	4,440	1.00	8,620	1.54
South Hadley	Mass.	Connecticut River	C	Primary	15,500	7,750	1.88	3,180	0.72	4,190	0.75
Holyoke	Mass.	Connecticut River	C	None	52,500	52,500	12.72	52,500	11.81	52,500	9.39
West Springfield	Mass.	" & Chicopee River	C	None	22,445	22,440	5.43	22,440	5.05	22,440	4.01
Springfield	Mass.	Connecticut River	C	Primary	150,000	75,000	18.17	65,500	14.74	115,000	20.57
Springfield	Mass.	Chicopee River	C	Primary	16,000	8,000	1.94	10,500	2.36	17,100	3.06
Agawam	Mass.	Connecticut River	S	Primary	12,510	6,300	1.53	5,200	1.17	9,050	1.62
Agawam	Mass.	Connecticut River	S	None	2,000	2,000	0.48	2,000	0.45	2,000	0.36
Longmeadow	Mass.	Connecticut River	S	Primary	10,000	5,000	1.21	4,900	1.10	9,400	1.68
Ludlow	Mass.	Chicopee River	S	Primary	4,400	2,200	0.53	15,600	3.51	17,500	3.13
Wilbraham	Mass.	Chicopee River	-	None	480	480	0.12	480	0.11	480	0.09
Westover Air Force Base	Mass.	Chicopee River	S	Primary	9,000	4,500	1.09	4,950	1.11	5,800	1.04
Chicopee	Mass.	Chicopee River	C	None	52,000	52,000	12.59	52,000	11.70	52,000	9.30
Westfield	Mass.	Westfield River	C	None	15,300	15,300	3.71	15,300	3.44	15,300	2.74
E. Longmeadow	Mass.	Pecousic Branch	S	Secondary and Cl	7,700	120	0.03	1,080	0.24	1,350	0.24
TOTAL MASSACHUSETTS					428,435	259,370	62.8	275,860	62.0	359,880	64.4
Thompsonville	Conn.	Connecticut River	S-C	Primary	13,500	6,750	1.63	7,420	1.67	8,770	1.57
Warehouse Point	Conn.	Connecticut River	S	None	1,240	1,240	0.30	1,240	0.28	1,240	0.22
Windsor Locks	Conn.	Connecticut River	S	Primary	8,500	4,250	1.03	4,680	1.05	5,520	0.99
Hartford	Conn.	Connecticut River	C	Primary	256,290	128,150	31.04	140,900	31.70	166,500	29.78
East Hartford	Conn.	Connecticut River	S	Primary	26,300	13,150	3.18	14,500	3.26	17,100	3.06
TOTAL CONNECTICUT					305,830	153,540	37.2	168,740	38.0	199,130	35.6
TOTAL ALL SOURCES					734,265	412,910		444,600		559,010	

* Type of System:

S = Separate Sewers
C = Combined Sewers

17-a

quantity of coliform bacteria contributed to a stream by the daily untreated sewage discharge from one person.

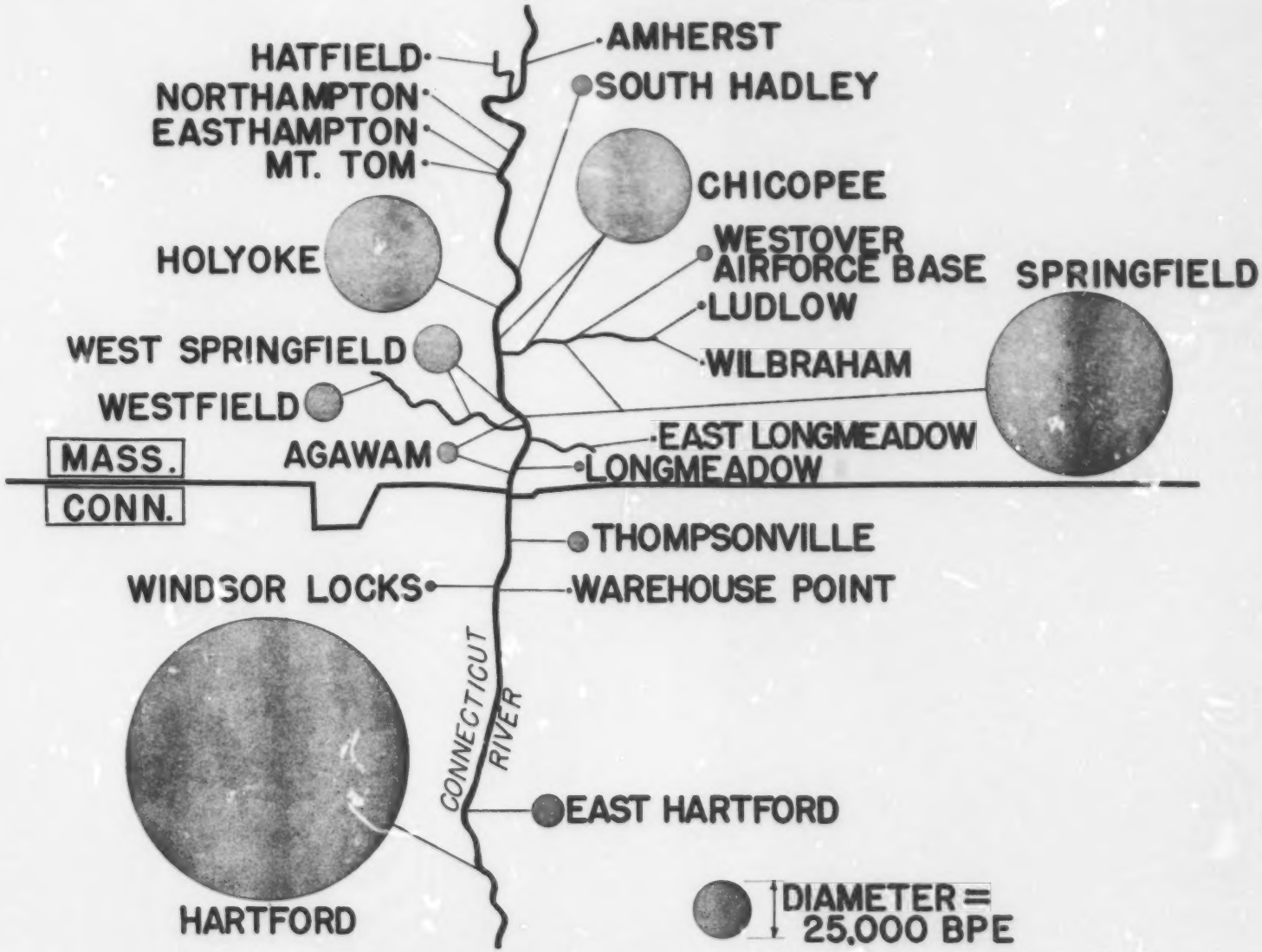
The data in Table 1 are shown graphically in Figure 2. This figure provides a visual impression of the relative proportion of the total bacterial load discharged from each source of sewage. The diameters of the circles are in proportion to the loads from the various jurisdictions. The diameter of the circle representing the scale is equivalent to the bacterial contribution of raw sewage from 25,000 persons.

Of the estimated total bacterial load, 63 per cent is discharged in Massachusetts and 37 per cent in Connecticut. Raw sewage discharges account for 36 per cent of the total and sources with only primary treatment account for 63 per cent. The four towns that provide chlorination are responsible for only 1.2 per cent of the total during the recreation season, although they contain nearly 9 per cent of the sewered population.

The two cities that account for the largest individual bacterial loads provide primary treatment. Hartford is the largest single source, with 31.0 per cent, or nearly one-third, of the total from all sources. Springfield is second, with 20.1 per cent. The next four towns, all in Massachusetts, provide no treatment. Holyoke accounts for 12.7 per cent, Chicopee 12.6 per cent, West Springfield 5.4 per cent, and Westfield 3.7 per cent. East Hartford, with primary treatment,

ESTIMATED BACTERIAL LOADS

FIGURE 2



281a

accounts for 3.2 per cent. Of the remaining 15 jurisdictions, three of which provide no treatment, none discharges more than two per cent of the total. The 15 jurisdictions combined are responsible for 11.3 per cent of the total bacterial load.

Suspended Solids

The raw sewage from all sources is estimated to have a suspended solids population equivalent (SPE) of 747,000. The previously described treatment by 15 of the 22 jurisdictions reduces the combined suspended solids about 40 per cent, to leave a total suspended solids population equivalent of 445,000 to be discharged to the streams. At 0.2 pounds of suspended solids per capita per day this is equal to 89,000 pounds per day.

The percentages of the total suspended solids load from all jurisdictions are given in Table 1. The percentages from each of the two states, the percentages from systems with and without treatment, and the relative proportions from the individual sources are quite comparable to those for bacterial loads, with four exceptions. The chlorination of Northampton, Easthampton, and Amherst sewage, which reduces those bacterial loads to very low percentages, has little effect on suspended solids reduction. Northampton, which ranks fourteenth in bacterial load, moves up to ninth in suspended solids. East

Hampton goes from nineteenth to fifteenth, and Amherst from eighteenth to sixteenth. Ludlow has a relatively small sewered population, and is fifteenth in bacterial load, but apparently receives considerable industrial waste and is sixth in suspended solids.

With these exceptions, the proportional suspended solids loads are similar to those for bacteria illustrated in Figure 2.

Oxygen Demand

The raw sewage from all sources is estimated to exert a 5-day biochemical oxygen demand (BOD) equal to a population equivalent (PE) of 764,000. The treatment provided reduces the combined oxygen demand about 27 per cent, leaving a PE of 559,000 to be discharged to the receiving streams. The percentages from each of the two states, the percentages from raw and treated sewage, and the relative proportions from individual sources are similar to those for suspended solids and it would be repetitious to give details here.

INDUSTRIAL WASTES

The industrial plants discharging wastes directly to the reaches of the Connecticut, Chicopee and Westfield rivers under consideration add little to the total bacterial pollution of the streams. Sewage from the employees is discharged without treatment at some of

the plants. Since most of the employees live in nearby sewered communities their sewage would reach the river through municipal systems if it were not discharged through the plant sewers. As municipal sewage treatment plants become available the sewage from the plant employees will be connected to the municipal systems or will be treated at the industrial plants.

Some of the industrial wastes have two constituents, oxygen demand and suspended solids, in common with sewage. Other waste constituents, which may have local but not interstate significance, are metals, dyes, acids and alkalies.

The 20 industries that discharge directly to streams are listed in Table 2. Included is information on waste constituents provided by the state water pollution control agencies, obtained from Public Health Service records, or estimated on the basis of assumptions that are believed to be reasonable.

Suspended Solids

Suspended solids data as such are not available from official records, and cannot readily be estimated for most of the plants.

The combined losses of fiber by the 11 paper mills probably constitute the major industrial organic suspended solids load discharged to the streams. Estimates of plant capacities were derived

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TABLE 2

Estimated Characteristics of Industrial Wastes Discharged to Connecticut River and Tributaries between Northampton, Massachusetts and Hartford, Connecticut

PLANT	LOCATION	CLASSIFICATION	RECEIVING STREAM	TYPE OF TREATMENT	Paper Mill Fiber		Oxygen Demand Population Equivalent	
					Pounds per Day	% Total	Number	% Total
Texon, Inc.	South Hadley, Mass.	Paper Mill	Connecticut River	None	900	3.88	430	0.44
American Writing Paper Corp.	Holyoke, Mass.	Paper Mill	Connecticut River	Save-alls	4,800	20.69	10,000	10.27
Chemical Paper Mfg. Co.	Holyoke, Mass.	Paper Mill	Connecticut River	None	7,500	32.33	5,750	5.90
Franklin Paper Co.	Holyoke, Mass.	Paper Mill	Connecticut River	None	2,100	9.05	900	0.92
Valley Paper Co.	Holyoke, Mass.	Paper Mill	Connecticut River	Save-alls	600	2.59	3,000	3.08
Whiting and Co.	Holyoke, Mass.	Paper Mill	Connecticut River	None	1,800	7.76	3,200	3.29
Springfield Rendering	Chicopee, Mass.	Rendering	Connecticut River	Flotation	-	-	5,000	5.13
Harden-Harvard Brewing Co.	Chicopee, Mass.	Brewery	Connecticut River	None	-	-	2,100	2.16
Utility Mfg. Co.	Wilbraham, Mass.	Misc. Metals	Chicopee River	None	-	-	-	-
Shavinigan Resins Corp.	Springfield, Mass.	Chemical	Chicopee River	None	-	-	24,600	25.25
Thal Dyeing Co.	Springfield, Mass.	Wool Dyeing	Chicopee River	None	-	-	1,240	1.27
Monsanto Chemical Co.	Springfield, Mass.	Chemical	Chicopee River	Phenol Recovery	-	-	10,500	10.78
U. S. Rubber	Chicopee, Mass.	Synthetic Rubber	Chicopee River	None	-	-	9,200	9.44
Foster Machine Co.	Westfield, Mass.	Machining	Westfield River	None	-	-	-	-
Stevens Paper Mill	Westfield, Mass.	Paper Mill	Little River	None	3,000	12.93	10,000	10.27
Westfield Mfg.	Westfield, Mass.	Metal Plating	Little River	None	-	-	-	-
Permoid Corp.	W. Springfield, Mass.	Paper Mill	Westfield River	None	900	3.88	3,000	3.08
Strathmore Paper Co.	W. Springfield, Mass.	Paper Mill	Westfield River	Save-alls	500	2.15	7,600	7.80
Southworth Co.	W. Springfield, Mass.	Paper Mill	Westfield River	Save-alls	200	0.86	400	0.41
TOTAL MASSACHUSETTS					22,300	96.1	96,920	99.5
C. H. Dexter and Sons, Inc.	Windsor Locks, Conn.	Paper Mill	Connecticut River	None	900	3.88	500	0.51
TOTAL CONNECTICUT					900	3.9	500	0.5
TOTAL ALL SOURCES					23,200		97,420	

21-2

from Lockwood's Directory of the Pulp and Paper Industry. It was assumed that plants with save-alls lose one per cent of the pulp used, and those without save-alls lose three per cent of the pulp. While an estimate for an individual mill may not be accurate, it is believed that the total for all mills is reasonable. The probability is that the total is conservative.

The total fiber loss for the 10 mills in Massachusetts is estimated to be 22,300 pounds per day. This is about 40 per cent of the estimated suspended solids load of 55,200 pounds per day discharged by all sources of sewage in the area of Massachusetts under consideration. Of the fiber loss 75 per cent of the total is estimated to be discharged by the five paper mills in Holyoke, 13 per cent by the mill in Westfield, 7 per cent by the three in West Springfield, and 4 per cent by that in South Hadley.

The single paper mill in Connecticut, at Windsor Locks, is estimated to discharge 900 pounds of fiber per day, which is 2.7 per cent of the 33,700 pounds per day of suspended solids discharged by sources of sewage in Connecticut.

The estimated suspended solids from all sources of sewage in the study area plus the estimated fiber losses from paper mills have a total SPE of 551,000.

Oxygen Demand

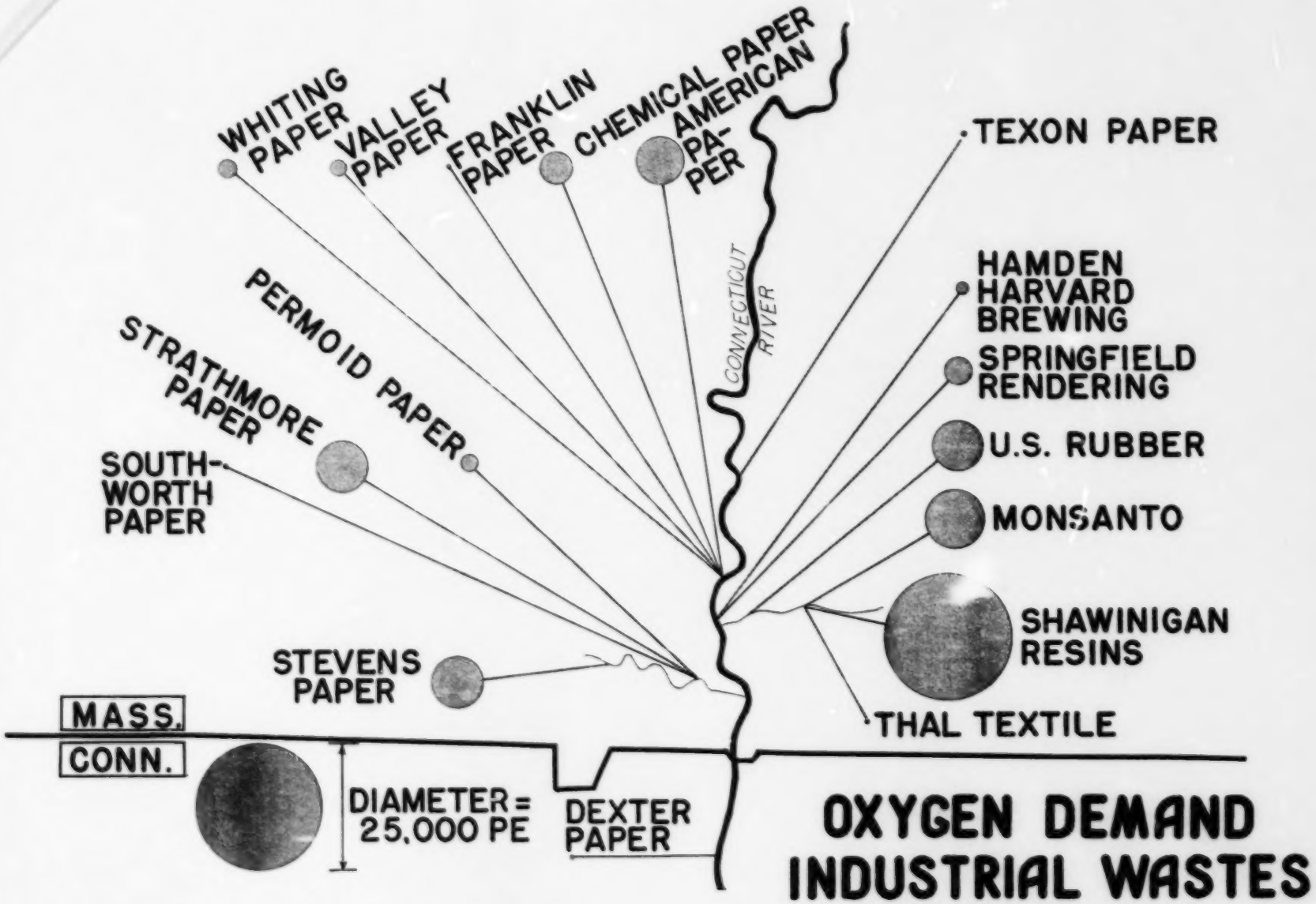
The industrial wastes of the study area above Hartford have a total estimated PE of 97,400. The relative sizes of the loads from individual sources are shown in Figure 3. Of this, 99.5 per cent enters the streams in Massachusetts, and 0.5 per cent in Connecticut.

In Massachusetts, 54 per cent of the industrial wastes PE is discharged to the Chicopee River in the Chicopee-Springfield area, 24 per cent to the Connecticut at Holyoke, and 22 per cent to the Westfield and Little rivers in the Westfield-West Springfield area.

The 10 paper mills as a group contribute 46 per cent of the total, the three synthetic chemical plants 46 per cent, and the rendering, brewing and textile plants combined 8 per cent.

The single paper mill in Connecticut above Hartford accounts for the total 500 PE of industrial wastes involved in that state.

The PE of all sewage and industrial wastes combined discharged to the streams in both states totals 656,000, which is only 78,000 less than that of all sewage before treatment.



OXYGEN DEMAND INDUSTRIAL WASTES

FIGURE 3

23-2

EFFECTS OF POLLUTION ON WATER QUALITY AND USES

Excessive bacterial pollution of a stream presents a health hazard to those who come in contact with the water. Excessive suspended solids diminish the beauty of water and settle to and blanket the stream bottom, where they form sludge deposits which can produce offensive odors, reduce or eliminate aquatic life on which fish feed, and interfere with fish spawning. Excessive oxygen demand reduces the dissolved oxygen of the water, which results in reduction or destruction of desirable aquatic life, including fish, and may produce offensive odors.

The data collected during the study to measure the effects of pollution are summarized in the Appendix. Table I-A is a list of sampling stations. Table II-A incorporates the average values of the bacteriological, chemical and physical determinations. Table III-A lists the biological findings.

BACTERIAL POLLUTION

Municipal sewage contains enormous numbers of bacteria, among which there usually are pathogenic bacteria, derived from human excreta, that can cause gastrointestinal diseases such as typhoid fever, diarrhea and dysentery. These pathogenic bacteria, in densities too low to be detected by available laboratory methods, can cause illness in persons who swallow water containing them. As the densities of pathogenic bacteria are reduced by sewage treatment, dilution or forces of natural purification the hazards of contracting disease are proportionately reduced.

Sewage also contains bacteria of the coliform group which typically occur in excreta, or feces, and can readily be detected even at low densities. These bacteria, harmless in themselves, are determined in stream studies involving sewage pollution as indicators of the probable presence of pathogenic bacteria. In the absence of adequate methods for detection in streams of other pathogenic organisms, such as viruses, coliform bacteria also serve as indicators of the probable presence of these organisms.

For many years the laboratory method for determination of the coliform group has been a principal tool used by sanitary engineers in evaluating bacterial pollution of streams. The coliform group has

been used by numerous state and interstate water pollution control agencies as a basis for water quality objectives for various water uses. Unfortunately the coliform group includes several types of bacteria which may come from sources other than excreta, and coliform data sometimes have been challenged because of this. In the last few years a method for specific detection of fecal coliform bacteria only has been developed. Although the method has the decided advantage of specificity, it has not been in use long enough to serve as a basis for quantitative water quality objectives. Both methods of bacterial measurement were applied to all samples in this study.

The results of both determinations are expressed in terms of most probable numbers, or MPN, per 100 milliters (ml) of water. One hundred ml is a little less than one-half cup. The coliform group usually is designated as total coliforms.

Neither Massachusetts nor Connecticut has adopted a total coliform objective of water quality for recreational uses such as boating and fishing. Where such an objective has been adopted the commonly used limit is 5,000 per 100 milliliters (ml) of water.

Both states have total coliform objectives for Class B waters, used for body contact sports such as swimming and skiing. The Massachusetts limit is a mean of 2,400 per 100 ml, and the Connecticut limit a mean of 1,000 per 100 ml. The latter limit was originated in Connecticut in studies of salt water bathing areas, and subsequently has

become the natural bathing water objective most generally used by water pollution control agencies.

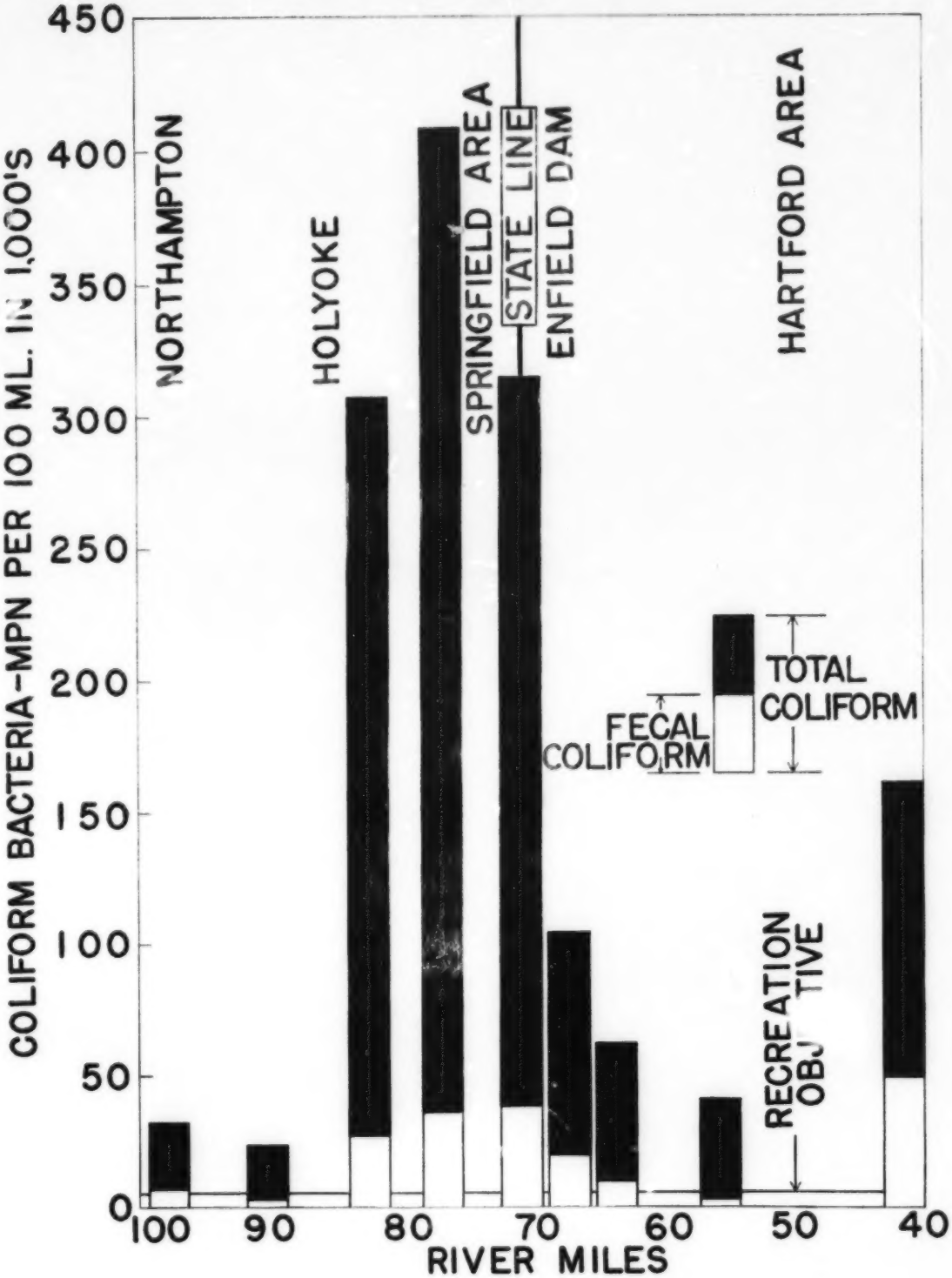
During the period September 30 through October 11, 1963, water samples from nine stations on the Connecticut River (Figure 1) were examined daily for total coliform and fecal coliform bacteria. Samples from three stations on the Chicopee River, three on the Westfield, and one on the Farmington were examined at the same time. Ten results were obtained at most stations on grab samples collected on Monday through Friday of each of the two weeks.

The average MPN values for both total and fecal coliform bacteria in the Connecticut River are plotted in Figure 4. Included on the chart is a line at the MPN value of 5,000 per 100 ml. This line permits comparison of the values found in the Connecticut River with the total coliform water quality objective most commonly used for general aquatic recreation, exclusive of body contact sports. The 2,400 and 1,000 per 100 ml lines representing the objectives of Massachusetts and Connecticut for swimming would, of course, fall below the 5,000 per 100 ml line, but are omitted because of the limited space.

Just above Northampton the total coliform MPN was over 31,000 per 100 ml, which is not acceptable for either general recreation or swimming. Hatfield, with a sewered population of 1,300, discharges raw sewage a few miles above Northampton, but this source alone could

COLIFORM BACTERIA

FIGURE 4



not account for the density of the coliform group found here. The next three towns upstream, Amherst, Sunderland, and South Deerfield provide chlorination of their sewage, and should not cause the high density if chlorination facilities were operated effectively. Montague discharges raw sewage many miles upstream, but is judged to be too far away to affect the result at Northampton significantly.

Towns in Massachusetts are required to chlorinate only during the recreation season, and since the recreation season had closed Amherst, with 16,000 sewered population, was not chlorinating its primary effluent during the study period. This, together with the raw sewage from Hatfield, could account for the finding at Northampton.

The effectiveness of treatment, including chlorination, of the sewage from the 30,000 population of Northampton is reflected by the drop in the total coliform density to approximately 23,000 per 100 ml above Holyoke. The unchlorinated sewage from Mt. Tom and Easthampton prevented an even greater decrease.

Below the raw sewage discharge at Holyoke and the Willimansett outfall of Chicopee the total coliform density soared to a peak MPN of 408,000 per 100 ml in the Springfield area, and then dropped to 315,000 per 100 ml at the state line. At this point, where the river enters Connecticut, the total coliform density was 63 times the objective for general recreation, and 315 times the Connecticut objective

for swimming. The fecal coliform density here was just under 40,000 per 100 ml. Anyone ingesting a single drop of water at this point would have swallowed at least 26 bacteria that originated in excreta that entered the river in Massachusetts.

An excellent confirmation of the total coliform MPN of 315,000 per 100 ml found at the state line is available in results obtained earlier by the Massachusetts Department of Public Health. Samples were collected every hour for 36 hours from the morning of September 18, 1963, through the evening of the 19th. The average MPN of these samples was 297,000 per 100 ml.

Both the total coliform and fecal coliform densities continued to drop to the last station above the Hartford area, where they were 41,000 and 2,600 per 100 ml, respectively. The total coliform density here was about 8 times the general recreation objective and 41 times that for swimming. An estimated one-third of the total coliform density and an undetermined fraction of the fecal coliform density were contributed by the treated sewage from Thompsonville and Windsor Locks, and the raw sewage from Warehouse Point in Connecticut.

In the Hartford area sewage from Hartford and East Hartford caused increases in total coliform and fecal coliform densities which reached 162,000 and 50,000 per 100 ml respectively. Here a drop of water contained an average of at least 33 bacteria derived from excreta,

of which not more than one probably originated in Massachusetts.

The total coliform density of the Chicopee River at North Wilbraham was 12,900 per 100 ml, and the fecal coliform a relatively low of 860 per 100 ml. From here the total coliform density increased to 141,000 per 100 ml below the Springfield Indian Orchard sewage treatment plant, and to 947,000 per 100 ml at the mouth of the Chicopee, below the raw sewage discharge from Chicopee. The fecal coliform MPN at the mouth was 116,000 per 100 ml. The bacterial densities at this point were by far the greatest found at any sampling station, and reflect the effects of raw sewage from Wilbraham and Chicopee, and of primary effluent from the Springfield Indian Orchard plant, Ludlow and the U. S. Westover Air Force Base.

On the Westfield River above Westfield the total coliform MPN was 12,300 and the fecal coliform 1,600 per 100 ml. Below Westfield the total coliform density increased to 312,000 per 100 ml, followed by a decrease to 142,000 per 100 ml at the mouth of the river. Sources of raw sewage involved were Westfield and West Springfield.

The Farmington River near its mouth yielded a total coliform density of 6,900 per 100 ml and a fecal coliform density of 2,300 per 100 ml.

The average flow of the Connecticut River during the sampling period was 3,460 cubic feet (cfs) per second. The stream flow during

the shad fishing season usually is much higher, with a mean monthly flow of record of 29,000 cfs in May, which is more than 11 times that during the study. The greater flow in May would provide greater dilution of the sewage with a corresponding decrease in bacterial densities. If it be assumed that the reduction in densities would be in direct proportion to the increased dilution the total coliform densities in May would range from about 38,000 per 100 ml at the state line to 4,900 per 100 ml above Hartford. There are sound reasons to believe, however, that actual densities in Connecticut during May would be higher than those calculated by straight dilution. The higher flow of the river results in a much higher velocity, and the water travels from Holyoke and the Springfield area to Hartford and intermediate points much more quickly. Since bacteria in a stream decrease as a function of time the decreased time of passage would permit considerably higher densities than those calculated at downstream points in Connecticut.

Some support for this conclusion is afforded by data obtained by the Connecticut Water Resources Commission in 1954. Samples were collected at 2-hour intervals for 24-hour periods at Thompsonville during June and August. The average total coliform density on the August sampling date was 35,400 per 100 ml when the stream flow was 6,260 cfs. In June, when the flow was nearly 50 per cent greater at 9,220 cfs, the MPN also was 50 per cent greater at 53,200 per 100 ml.

It is obvious that bacterial pollution discharged to the Connecticut River in Massachusetts causes a health hazard to persons who come in contact with the river for any recreational or other purpose in Connecticut as well as in Massachusetts. Hartford and East Hartford sewage contribute substantially to the excessive bacterial densities below the Hartford area.

SUSPENDED SOLIDS

Total suspended solids increased from an average of 7.0 milligrams per liter (mg/l) above Northampton to about 15.0 mg per liter below the Springfield area. This represented an increase in the load of suspended solids carried by the river of about 145,000 pounds per day, which was nearly twice as great as the estimated suspended solids load discharged from all sources in Massachusetts, including the fibers from the paper mills. There undoubtedly were more suspended solids from waste sources than are accounted for by the estimates. It was noted earlier that no estimate of total suspended solids from most industrial wastes could be made.

Despite the fact that suspended solids in the river were in excess of those accounted for by the waste estimates, quantities of solids settled to the bottom of the river in the Enfield impoundment to form sludge deposits. Bottom sampling revealed sludge worm populations from below Holyoke to Enfield Dam in Connecticut. Major sludge

beds were found immediately below Holyoke and at the bend of the river upstream from the North End Bridge in Springfield. In the vicinity of the Holyoke sewers fibers deposited from the paper mills wastes were several feet deep. Some pulp fibers were found in sludge samples collected as far downstream as Enfield Dam. Sludge collected above Springfield had a particularly strong, sour odor, which resembled that of vomitus.

An interesting observation was that of small plastic particles or beads that were found in sludge samples collected below the Chicopee River. The beads were found relatively undiminished in numbers, as far downstream as the station at the South Glastonbury-Rocky Hill Ferry below Hartford, 40 miles below the Chicopee River. Beads were found in the mouth of the Chicopee, and it is probable that these beads were discharged to the river from one or more industries on the Chicopee River.

Volatile suspended solids represent the organic portion of the total suspended solids. This organic portion is decomposable, and accounts for the oxygen demand exerted by sludge deposits and the offensive odor of hydrogen sulfide, commonly called a rotten egg odor, given off by decomposing sludge.

The volatile solids increased from 3.1 mg/l above Northampton to 7.3 mg/l at the state line. This represents an increase of 63,600

pounds per day, which is only 17,000 pounds per day less than the estimated load of total suspended solids from all sources of wastes. The previous discussion of the unaccounted for suspended solids load probably applies as well to the volatile solids.

The organic, or decomposable, content of the sludge was attested by the gas bubbles rising to the surface of the river over the major sludge deposits, and by the rotten egg odor given off by sludge samples when collected.

The sludge deposits in Enfield impoundment contribute to the depletion of dissolved oxygen below the desirable 5 mg/l minimum that occurs from time to time at the state line as described in the next section.

The blanket of sludge on the bottom of the river covers areas that otherwise would be used by fish in spawning, and thereby reduces the fish population below its potential. In addition, the sludge covered bottom is not a suitable habitat for the insect larvae and other aquatic life which normally live on the bed of a clean stream and serve as food for fish. Bottom aquatic organisms suitable for sport fish food were virtually non-existent throughout Enfield impoundment. As a result, the fish population that develops in the impoundment is limited, and consists mainly of carp and bullheads.

Among the aquatic forms which inhabit the bottoms of badly polluted streams in large numbers are sludge worms, which thrive on the

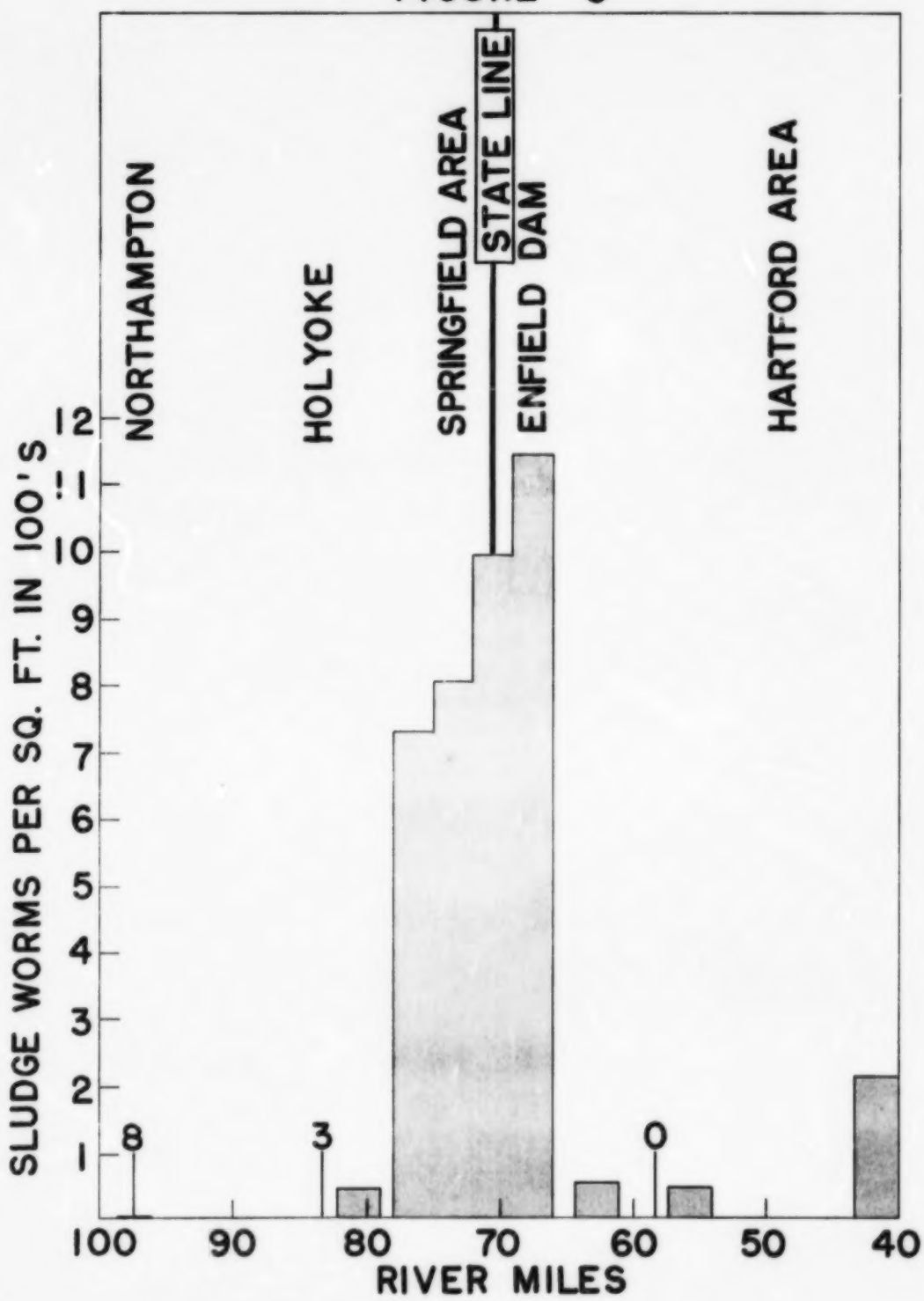
organic matter in the sludge. These worms unfortunately are not suitable food for sport fish. The numbers of sludge worms per square foot of bottom area were determined at several locations, with the results shown in Figure 5. Above Northampton the river bottom was relatively clean, and only 8 sludge worms per square foot were found. Immediately below Holyoke conditions in the major sludge deposit were so foul that even the worms could not thrive and only three per square foot were found here. Downstream the worms were well established, increasing to 730 per square foot above Springfield and 994 at the state line. The maximum number found at any point was 1,143 per square foot just above Enfield Dam, which is 2.7 miles below the state line. Below the dam sludge deposits decreased and the sludge worms dropped to less than 50 per square foot, but increased to 211 per square foot below the Hartford area. In the mouth of Westfield River there were 575 sludge worms per square foot and 1,408 in the mouth of the Chicopee River.

In the areas of major sludge deposits decomposing clumps and rafts of sludge boil to the water surface, buoyed by the gas bubbles of decomposition. These unsightly masses decrease the aesthetic appeal of the stream below Holyoke and in the vicinity of Springfield.

Class C standards of water quality adopted by both Massachusetts and Connecticut require that there be no sludge deposits. Class D standards require that sludge deposits not be objectionable.

SLUDGE WORMS

FIGURE 5



OXYGEN DEMAND AND DISSOLVED OXYGEN

Both sewage and many industrial wastes contain organic matter that decomposes and exerts an oxygen demand in the receiving stream. In the process of decomposition oxygen derived from the atmosphere and dissolved in the water is used, and the normal content of dissolved oxygen (DO) is reduced. If the DO is reduced below an adequate level the fish population and the aquatic life on which the fish feed are reduced. Most water pollution control agencies have adopted an average of 5 mg/l as the minimum DO that is adequate to maintain the maximum potential sport fish population.

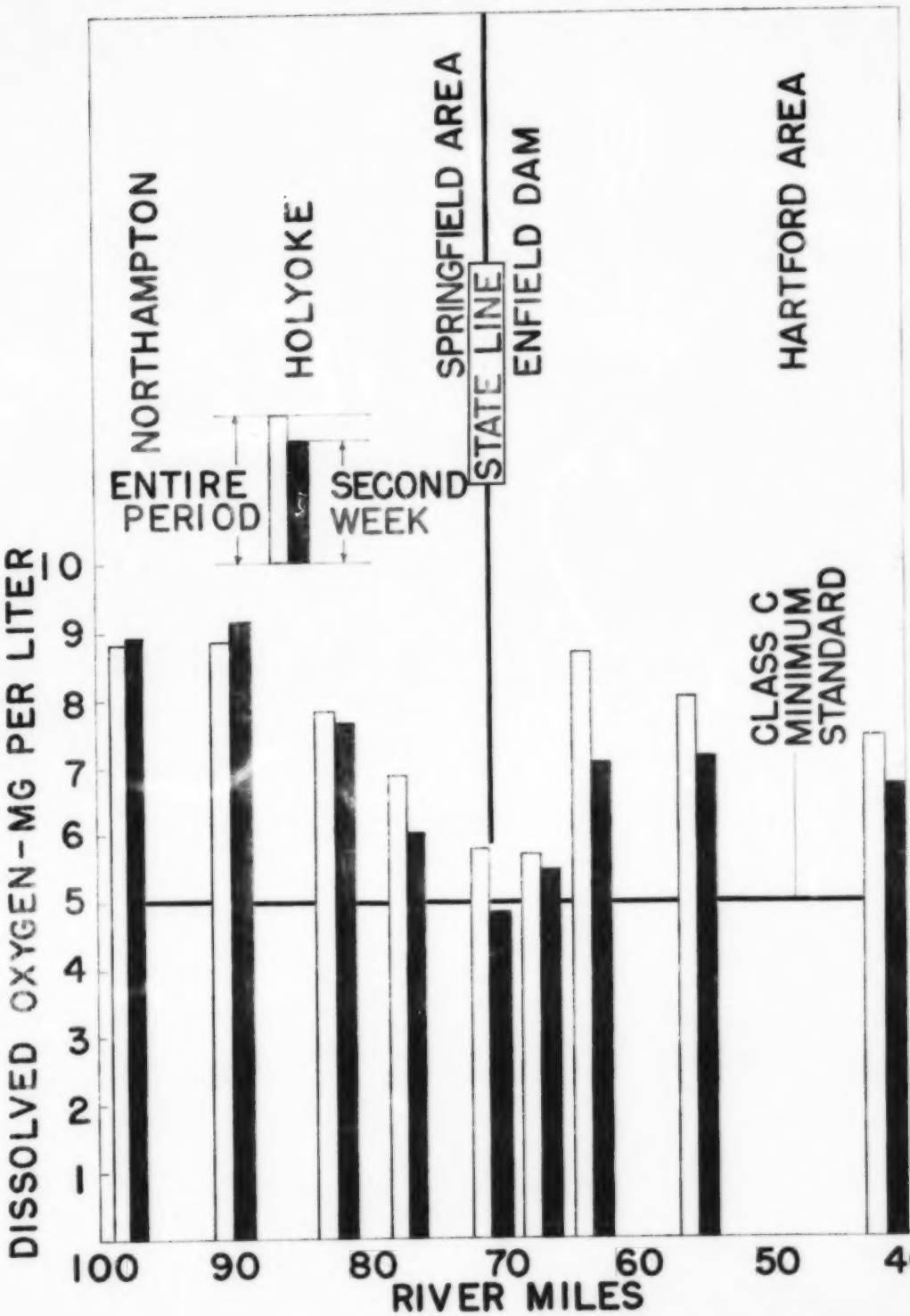
Both Massachusetts and Connecticut have adopted 5 mg/l as one of the minimum standards of quality for Class C waters. One of the definitions of Class C waters is: "suitable habitat for -- common food and game fishes indigenous to the region."

During the two-week study the BOD from sources in Massachusetts reduced the average DO from 8.8 mg/l at Northampton to 5.8 mg/l at the state line.

The DO at all sampling stations on the Connecticut River is shown in Figure 6, both for the entire sampling period and for the second week only. A heavy rainfall occurred the day before sampling started and as a result the stream flow was higher during the first than the second week. The average flow of 2,020 cfs for the second week was near a record minimum.

DISSOLVED OXYGEN

FIGURE 6



During the second week the DO increased from 8.9 mg/l above Northampton to 9.2 above Holyoke, and then dropped steadily past Holyoke and the Springfield area to 4.9 mg/l at the state line. At Enfield Dam it had increased to 5.5 mg/l and continued upward to about 7.0 mg/l above Hartford. When the river passed the Hartford area, the DO again dropped slightly to 6.8 at the South Glastonbury-Rocky Hill Ferry.

The DO at the state line was less than the standard of 5.0 mg/l on three of the five sampling dates during the second week. The three values were 4.9, 4.4 and a minimum of 4.0 mg/l. At Enfield Dam the DO was less than 5.0 mg/l on two of 10 sampling dates, with values of 4.5 and 4.8 mg/l.

The samples at the state line were collected near noon on all dates of the second week. If it had been feasible to sample at night it is probable that even lower DO values would have been found. The Massachusetts Department of Public Health collected samples at the state line for two days and one night in September, 1963. The samples collected at 11:00 AM and 12:00 noon on the two days averaged 7.3 mg/l of DO. The samples from 2:00 AM to 5:00 AM averaged 5.7 mg/l, or 1.6 mg/l less than those around noon.

There is additional evidence that the DO in Enfield impoundment drops below 5 mg/l at times. In 1956 the Public Health Service conducted an intensive study of the Enfield impoundment. At a station

about two miles above the state line the DO of 13 samples collected both day and night during the period August 28 through 30 averaged 2.8 mg/l. At Thompsonville the DO samples collected every two hours for 24 hours during August 29-30 averaged 5.0 mg/l, but four early morning samples averaged only 3.3 mg/l.

The Public Health Service maintains a Water Quality Network sampling station at Enfield Dam. Samples for DO determination have been collected there weekly for about two years. On August 14, 1963, the DO reported was 4.7 mg/l and on September 5, 1962, it was 4.3 mg/l. Both results were obtained from daytime samples.

There is ample evidence that the DO at and below the state line intermittently drops below the 5.0 mg/l average that is considered necessary for optimum propagation of fish and the aquatic life on which they feed.

The organic wastes producing the oxygen demand that lowers the DO are reflected in prolific growths of minute aquatic plants and animals. From Springfield to below Windsor Locks the aquatic plants, or algae, combine with oil and other suspended and floating matter to adhere to and form unsightly scum on boats near the water line. Considerable effort and expense on the part of boat owners is required to remove the scum.

The tremendous numbers of bacteria that live on and decompose the oxygen demanding organic matter give rise in turn to large numbers

of minute aquatic animals which live on the bacteria. These animals, individually invisible to the naked eye, attach themselves to submerged surfaces from Springfield to Hartford in such masses that they appear as slimes to the unaided eye.

AESTHETIC CONSIDERATIONS

The adverse effects of floating sludge on the beauty of the Connecticut River in certain areas already has been mentioned. Other floating materials also detract from the river's beauty in some areas, and contribute to the public's opinion that the Connecticut is badly polluted.

Below Holyoke, before the sewage and other wastes are mixed with the full flow of the river, the visible effects of pollution are ever changing. The fibers and fillers from paper plants impart a turbid appearance to the water at times. At other times various colors appear below the points where canals and sewers discharge, presumably caused by dyes used in colored papers. The raw sewage causes the dull slate grey appearance typical of sewage everywhere. Bits of human excreta and small grease balls float on the surface of the water, and streaks of oil film appear from time to time.

In the vicinity of the Springfield primary treatment plant effluent small grease balls and the typical grey sewage appearance

were noted. Similar evidence of sewage was observed below the Agawam sewers.

Condoms floated on the surface or lodged on obstructions along the river bank at numerous points. The farthest downstream that condoms were seen was in the vicinity of the Longmeadow Yacht Club near the state line.

The Westover Air Force Base sewage is reported to be septic at the point of discharge to Chicopee River and to cause a local odor nuisance.

COMBINED SEWERS

Nine of the municipalities, with a total sewered population of 595,000, have combined sewers. Combined systems, which are common in older municipalities throughout the country, receive both domestic sewage and storm water.

It is not economical to design sewage treatment plants to treat the large quantities of sewage and storm water which enter combined systems during storms. As a result, overflow devices are provided to bypass portions of the mixed storm flows from the system to the nearest watercourse without treatment. Thus the raw sewage diverted during storms intermittently causes pollution of the receiving stream even after treatment for dry weather sewage flow has been provided.

Control of this type of intermittent pollution can be accomplished only by provision of separate sewers for sewage and storm water, or by the installation of large storm water treatment units as an adjunct to the principal sewage treatment plant.

RADIOACTIVITY

The Yankee Atomic Energy Company operates a commercial nuclear generating station at Rowe, Massachusetts, in the northwest corner of the state. Treated wastes are discharged under careful control to the Deerfield River, 41 miles above the confluence of the Deerfield and Connecticut rivers. This confluence is 17 miles above the upper limit of the study area, but the possibility of radioactive pollution was investigated because of the persistence of some radioisotopes.

The Public Health Service maintains National Water Quality Networks stations on the Connecticut at Northfield, Massachusetts, above the Deerfield River, and at Enfield Dam in Connecticut. Comparison of data on gross radioactivity at these two stations has shown no evidence that the Yankee Atomic Energy Company is contributing significant radioactivity to the Connecticut River.

OTHER DETERMINATIONS

Temperature and pH determinations were made on all samples. Weekly composites were analyzed for the metals that are commonly used in metal plating. One set of samples was examined for phenols.

No significant effects of pollution other than those already discussed were indicated by the results of these determinations.

LOCAL POLLUTION

There are problems of local pollution on the Connecticut River System which are beyond the limits covered by this report. Although not judged to contribute to pollution of interstate waters, this does not imply and must not be interpreted to mean that such problems are not serious or that correction is unnecessary. On the contrary, the prospect of correction of the sources contributing to interstate pollution should stimulate others outside of the area to undertake simultaneous corrective measures so that the ultimate potential use of the priceless water resources of the Connecticut River System can soon be realized for the benefit of the citizens of both states.

SUMMARY AND CONCLUSIONS

The beautiful Connecticut River is the major interstate stream of New England. Between its headwaters near the Canadian border and its mouth, 400 miles downstream in Long Island Sound, it flows between New Hampshire and Vermont and across Massachusetts and Connecticut.

This report deals with 62 miles of the river, from Hatfield, Massachusetts, to the South Glastonbury-Rocky Hill Ferry, 12 miles below Hartford, Connecticut. Portions of the Chicopee and Westfield rivers, tributaries to the Connecticut River near Springfield, Massachusetts, are included.

This reach of the river is used principally for waste disposal, industrial water supply, hydro power, and aquatic recreation. Minor uses are commercial fishing and navigation.

Two dams, Holyoke and Enfield, on the main stream divert water to canals which serve numerous industries as sources of process water

supply and hydro electric power. Several smaller dams serve the same purposes on the Chicopee and Westfield rivers. Four thermal power plants and an aircraft plant use more than a billion gallons of cooling water daily.

The quiet impounded waters above Holyoke dam and the tidal reach in the vicinity of Hartford invite boating, water skiing, fishing and swimming. Enfield impoundment is used for boating and fishing. At least 10 boat ramps and docking areas, six in Massachusetts and four in Connecticut, provide ready access to the river between Northampton, Massachusetts, and Hartford, Connecticut.

The dramatic shad run each spring lures hundreds of fishermen to the river in both Massachusetts and Connecticut. An annual average of 19,000 man hours spent in fishing yields an average of 27,000 shad each year. In addition, commercial fishermen in Connecticut net 98,000 shad yearly. The shad run occurs when stream flows are relatively high, and visual effects of pollution are not so obvious as they are at lower flows.

The river in Connecticut, between Enfield Dam and Hartford, supports good populations of a variety of both sport and coarse fishes. For some reason little advantage is taken of this excellent fishery. A former official of the Connecticut Board of Fisheries and Game has suggested the reason may be that many sportsmen associate the river with gross pollution and uncleanliness.

This association is not without foundation. Sixteen jurisdictions in Massachusetts and five in Connecticut discharge raw and partially treated sewage from a total sewered population of nearly three-quarters of a million persons. One town in Massachusetts provides complete treatment. Reductions accomplished by treatment reduce the total loads of bacteria and suspended solids by about 40 per cent and the oxygen demand about 27 per cent. A little less than two-thirds of the total residual waste constituents are discharged to the streams in Massachusetts and a little more than one-third in Connecticut.

In addition, industries discharge suspended solids and oxygen demanding materials estimated to be equivalent to those in raw sewage from a sewered population of about 100,000.

The combination of sewage and industrial wastes causes excessive pollution of the Connecticut River. Massachusetts and Connecticut are members of the New England Interstate Water Pollution Control Commission. In 1955, under the auspices of the Commission, the two states designated the condition of the entire reach of the river, with the exception of a few miles above Hartford, as Class D. The Commission defines the quality of Class D waters as "suitable for transportation of sewage and industrial wastes without nuisance, and for power, navigation and certain industrial uses." At the same time the states proposed and the Commission adopted the future highest use classification of the river from Holyoke to below Hartford as Class C. Class C waters

are defined as suitable for recreational boating, irrigation of crops not eaten without cooking, habitat for common food and game fishes and industrial cooling and processing.

At that time five of 16 towns in Massachusetts provided sewage treatment. Since then three additional towns have placed treatment facilities in operation. Eight jurisdictions still discharge untreated sewage, but one has a treatment plant under construction, and two are arranging to convey the sewage to neighboring treatment plants. Only limited progress has been made in treatment of industrial wastes.

A study by the Public Health Service in October 1963 provided information on the present condition of the Connecticut River.

At no point on the river did the bacterial quality of the water meet the objectives most commonly used by water pollution control agencies. At the state line the total coliform bacteria density was 63 times a commonly used objective for general recreation, and 315 times the Connecticut standard for swimming. A few miles above Hartford the bacterial density was 8 times the recreational objective and 41 times the swimming standard. Below the Hartford area the density rose again, to 32 and 160 times the desirable limits. These bacterial densities, derived from sewage, indicate that health hazards are involved in use of the water for recreation.

Suspended solids from sewage and industrial wastes produced sludge deposits throughout the impoundment from a short distance

below Holyoke Dam to Enfield Dam in Connecticut. Paper fibers were found in all sludge collected. The sludge, covering the river bottom, interferes with fish spawning and the development of insect larvae and other aquatic life which serve as food for fish. As a result desirable sport fish do not exist in these areas, and only carp and bullheads prosper in Enfield impoundment. Bottom organisms suitable for sport fish food were virtually nonexistent. The decomposing sludge contributes to the oxygen demand imposed on the stream and to depletion of dissolved oxygen in the water. In addition, gases of decomposition cause clumps and rafts of sludge to boil to the surface where they are aesthetically offensive. When sampled during the study the sludge gave off a hydrogen sulfide, or typically rotten egg, odor.

The oxygen demand exerted by the sewage and industrial wastes in the process of decomposition intermittently causes depletion of dissolved oxygen below the desirable level. Five mg/l of dissolved oxygen generally is accepted as the minimum necessary for propagation of a well balanced fish population and the bottom organisms on which they feed. This minimum is one requirement of the Commission standards for Class C waters. The dissolved oxygen of water at the state line averaged 5.8 mg/l during the sampling period, but was below the standard on three of the 10 sampling days, and averaged less than 5 mg/l for the second week of the study. Data from other sources show that this was not an isolated occurrence.

Visual evidences of pollution which diminish the beauty of the water and are offensive aesthetically included: cloudy and greyish appearance of the water in the vicinity of sewage and industrial waste discharges; intermittent colors of dyes from industrial wastes; small grease balls, bits of human excreta and condoms in the vicinity of sewage discharges; intermittent oil films on the surface of the river; and combinations of algae, oil and other floating materials which caused a green scum at the water lines of boats moored on the river.

It is obvious that sewage and industrial wastes discharged to the Connecticut, Chicopee and Westfield rivers in Massachusetts cause pollution of the Connecticut River which endangers the health and welfare of persons in Connecticut and therefore is subject to abatement under the provisions of the Federal Water Pollution Control Act.

APPENDIX

TABLE I-A - SAMPLING STATIONS
" II-A - SUMMARY OF FIELD DATA
" III-A - MEAN NUMBER BOTTOM ANIMALS PER SQUARE FOOT - CONNECTICUT RIVER, October, 1963
" III-A - Continued - CONNECTICUT RIVER TRIBUTARIES, October, 1963

CONNECTICUT RIVER
MASSACHUSETTS-CONNECTICUT

TABLE I-A

Sampling Stations

RIVER MILE	DESCRIPTION
C -97.3	State Hwy. 9 Bridge above Northampton, Massachusetts.
C -86.0	State Hwy. 202 Bridge above Holyoke, Massachusetts.
C -82.3	Just upstream from Paderewski Pumping Station, above mouth of Chicopee River.
C -76.8	Boston and Maine Railroad Bridge, above Springfield, Massachusetts, Bondi Island Sewage Treatment Plant and Westfield River.
C -70.7	Massachusetts-Connecticut State Line.
C -68.0	Just above Enfield Dam.
C -63.8	State Hwy. 140 Bridge at Windsor Locks, Connecticut.
C -55.2	State Hwy. 291 Bridge (Bissell Bridge) at Wilson, Connecticut.
C -40.3	South Glastonbury-Rocky Hill Ferry, State Hwy. 160, below Hartford, Connecticut.
Ch-11.3	Cottage Street Bridge, just north of U.S. Hwy. 20 at North Wilbraham, Massachusetts.
Ch- 4.7	Just off State Hwy. 141, under access to U.S. Interstate Hwy. 90.
Ch- 0.0	Mouth of Chicopee River.
W -11.4	State Hwy. 10 at Westfield, Massachusetts, above Westfield sewers.
W - 7.8	Just off U.S. Hwy. 20 at U.S.G.S. Gaging Station.
W - 0.0	Mouth of Westfield River.
F - 1.2	U.S. Hwy. 5-A at Windsor, Connecticut.

C - Connecticut River
Ch - Chicopee River
W - Westfield River
F - Farmington River

CONNECTICUT RIVER
MASSACHUSETTS-CONNECTICUT

TABLE II-A

Summary of Field Data

Station River Mile	Dates 1963	Temp. ° C.	Coliform Bacteria MPN per 100 ml		Dissolved Oxygen		5-Day BOD	Suspended Solids-mg/l		pH	Discharge
			Total	Fecal	mg/l	% Sat.	mg/l	Total	Volatile		cfs
C -97.3	9/30-10/11*	14.9	31,400	6,320	8.80	86.6	1.79	7.0	3.1	7.3	
C -86.0	"	15.6	22,800	3,220	8.86	88.6	2.14	10.3	4.1	7.4	
C -82.3	"	16.6	307,000	27,800	7.85	79.7	6.53	20.7	10.8	7.2	
C -76.8	"	16.6	408,000	35,900	6.85	68.6	3.92	15.1	8.3	7.1	
C -70.7	"	16.6	315,000	38,900	5.76	58.4	3.77	14.6	7.3	7.1	
C -70.7	10/7-10/11	16.8	270,000	12,800	4.88	49.7	3.92	13.3	7.6	7.1	
C -68.0	9/30-10/11	16.7	105,000	19,800	5.74	61.7	3.65	13.7	7.0	7.2	3,460
C -63.8	"	16.1	62,500	5,950	8.71	88.8	3.38	13.2	6.3	7.4	
C -55.2	"	15.6	41,000	2,600	8.03	80.7	3.40	16.1	6.9	7.3	
C -40.3	"	16.8	162,000	50,100	7.24	74.2	4.15	20.0	8.3	7.2	
Ch-11.3	"	15.1	12,900	860	9.20	90.5	1.62	6.5	4.0	6.6	
Ch- 4.7	"	15.5	141,000	26,000	6.46	64.3	11.5	18.9	13.8	6.7	273
Ch- 0.0	"	15.4	947,000	116,000	4.65	46.0	6.86	17.3	10.5	6.8	
W -11.4	"	14.5	12,300	1,600	8.98	87.3	2.41	12.8	4.6	7.3	
W - 7.8	"	14.9	311,500	36,200	5.62	54.9	4.44	12.3	6.2	7.0	301
W - 0.0	"	15.7	142,500	10,000	6.02	59.8	3.48	16.0	4.9	7.1	
F - 1.2	"	14.3	6,900	2,300	9.06	87.7	1.80	15.4	3.5	7.2	484

* Exclusive of 10/5 and 10/6.

CONNECTICUT RIVER
MASSACHUSETTS-CONNECTICUT

TABLE III-A

Mean Number Bottom Animals Per Square Foot
Connecticut River, October, 1963

Station Location	River Mile	Sludge-worms	Midges	Leeches	Limpets	Snails	Planaria	Fingernail Clams	Caddis-flies	Clams
Control North Hampton	97.3	8	36	-	-	-	-	-	-	-
Enolds Marine Below Holyoke	83.0	3	-	-	-	-	-	-	-	-
Mass. Turnpike Bridge	82.1	42	8	-	-	-	-	-	-	-
Chicopee River Enters	80.4									
Hwy 20A Bridge	77.4	730	-	-	-	-	-	-	-	-
Westfield River Enters	75.0									
Below Hwy 5 (South) Bridge	74.8	804	4	-	6	-	-	-	-	-
State Line	70.7	994	8	-	-	-	-	-	-	-
Enfield	68.4	1143	18	-	6	128	22	-	-	1
Below Enfield Dam	67.9	48	396	-	-	264	336	96	456	-
1 Mile Above Farmington R.	58.1	-	1034	-	4	-	-	-	61	1
Bissell Bridge	55.2	42	63	-	-	-	1	-	8	1
South Glastonbury	41.0	211	163	12	-	-	3	-	-	1

CONNECTICUT RIVER
MASSACHUSETTS-CONNECTICUT

TABLE III-A

Mean Number Bottom Animals Per Square Foot
Connecticut River Tributaries, October, 1963
(Continued)

Location	River Mile	Sludge-worms	Midges	Leeches	Limpets	Caddis-flies	Stone-flies	May-flies	Snipe Flies	Misc.
CHICOPEE RIVER										
Cottage St. Bridge North Wilbraham	11.3	-	-	4	-	400	4	-	-	4
West St. Bridge Springfield-Ludlow Mid-stream Sample	7.3	-	8	16	-	600	-	-	-	8
Mass. Turnpike Access Bridge	4.7	28	-	-	-	-	-	-	-	-
River Mouth	0.1	1408	448	-	-	-	-	-	-	-
WESTFIELD RIVER										
Near Russell	20.0	-	80	-	4	480	1	4	4	25
Upstream from Westfield	12.0	6	240	-	32	1984	1	80	48	1
Below Westfield	7.8	17	6	-	-	-	-	-	-	1
River Mouth	0.1	574	-	-	-	-	-	-	-	-